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January 13, 1997

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

William F. Caton
Acting Secretary
Federal Communications Commission
1919 M St. N.W., Room 222
Washington, D.C. 20554

Re: Ex Parte Filing of Primosphere Limited Partnership in GN Docket 96-228

Dear Mr. Caton:

On January 10, 1997, Primosphere Limited Partnership filed an ex parte statement regarding meetings with various Commission staff members on January 6, 7, and 8, 1997. The purpose of those meetings was to discuss the out-of-band emissions limits proposed in the Notice of Proposed Rulemaking in the above-referenced docket. In addition, on January 10, 1997 Primosphere representatives met with John Williams of the Office of Plans and Policy and Thomas Tycz of the International Bureau, also to discuss the out-of-band emissions proposal.

Attached hereto is a supplemental filing providing information promised to the staff at these meetings.

If you have any questions, please call me.

Very truly yours,

Robert J. Ungar

cc (w/encl.): Richard Smith
Bruce Franca
Tom Mooring
Charles Iseman
Michael Marcus
David Siddall

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Julius Genachowski
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Johnathan Cohen
D'wana Speight
Thomas Stanley
Thomas Tycz
Don Gips
Steve Sharkey
John Williams

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Technical Statement of Primosphere LP

Amendment of the Commission's Rules to Establish Part 27,
the Wireless Communications Service ("WCS")
GN Docket N. 96-228

January 13, 1997

1. Allocation of Spectrum to Wireless Communications Services and Conditions of Use

The Commission in its NPRM of November 8, 1996 proposed that the bands 2305 to 2320 MHz and 2345 to 2360 MHz be allocated to Wireless Communication Services (WCS) for flexible use. Flexible use might include mobile and fixed services. The two WCS bands are adjacent to the band 2320 to 2345 MHz that the Commission previously allocated to Satellite Digital Audi Radio Service (SDARS).

In allocating spectrum to WCS the Commission recognized the need to protect the sensitive satellite receive services in the band allocated to SDARS and placed an out-of-band emission limitation on the WCS services. The level of out-of-band emission from the WCS bands into the SDARS band proposed by the Commission is;

For WCS fixed transmit services 70+10Log(p) dB
For WCS mobile transmit services 43+10Log(p) dB

where p is the power level of the WCS transmitter in watts

No other technical constraints were placed on transmissions in the WCS bands.

2. Issues

In their comments to the Commission with regard to the WCS NPRM Primosphere, and other SDARS applicants, took issue with the above limit on WCS out-of-band emissions into the band allocated for SDARS. These Comments noted that the level of protection from WCS generated interference was inadequate to protect the low level satellite receive signals in the SDARS band. It was further noted that these limits would, if implemented, result in very significant and frequent disruption of SDARS reception over a wide area. Mobile transmitters in the WCS bands meeting the proposed out-of-band emission limits will subject SDARS mobile receivers to an excessive level of noise. Primosphere calculates (see Figure 1) that a single WCS transmitter at a range of approximately 5 km away from an SDARS receiver will provide a level of interference into the SDARS receiver equal to the SDARS receiver's total noise level. At a range of 1 km this WCS transmitter will render the SDARS receiver inoperative.

3. Solution

Primosphere in its response to the NPRM has proposed a revised set of out-of-band emissions limits. These limits are based on reasonable allowances for interference into the SDARS system and practical approaches exist to implementing the out-of-band emission requirements in either the mobile or fixed WCS transmitters. Specifically Primosphere has proposed the following requirements for the WCS out-of-band emissions into the SDARS band:

For WCS fixed transmit services	92+10Log(p) dB
For WCS mobile transmit services	123+10Log(p) dB

In addition Primosphere has suggested the use of opposite sense circular polarization between the WCS and SDARS bands. It is proposed that both WCS bands would use circularly polarized transmissions of the opposite sense to the SDARS receive transmissions.

No other constraints on or changes to WCS transmissions have been proposed.

4. Justification for revised WCS out-of-band emission limits

The Primosphere SDARS satellite-to-mobile link design allocates 200° K to receiver noise temperature. The system designs of other SDARS applicants are based on similar levels of SDARS receiver noise temperature. Assuming only a **single** WCS transmitter is within line of sight of an SDARS receiver, Table 1 shows calculations that support the need for the above levels of out-of-band emissions. These calculations are based on an SDARS receiver noise temperature of 200° K and allows a 5 % increase in SDARS noise for WCS transmissions from **single** WCS transmitter. The estimate of SDARS receiver noise temperature of 200° K is based on a receiver LNA noise figure of 1 dB (see attached data sheet for NEC part NE32584C, a low noise amplifier meeting this requirement) and a line loss plus antenna noise of 120°K. An allowance for WCS interference increasing SDARS receiver noise temperature by 0.2 dB is justified, since this is for only one WCS transmitter and WCS is not the only interfering signal faced by SDARS receivers. SDARS receivers must contend with interference from other nearby bands, from within the SDARS band itself from the second SDARS licensee and from Canadian terrestrial systems who also share the SDARS. The numbers in Table 1 are derived from standard methods of calculation.

Based on the results shown in Table 1, Primosphere has plotted the out-of-band emissions from a **single** WCS mobile or fixed transmitter fully meeting the proposed out-of-band emission limits of 43+10Log(p) and 70+10Log(p) dB respectively, versus separation distance between the offending WCS transmitter and an SDARS receiver. The results are given in Figure 2. It can easily be seen that a **single** WCS mobile transmit terminal, in full compliance with the currently proposed out-of-band emission limits will produce a noise level at the SDARS receiver equal to SDARS receiver noise, when located approximately 5 km away. This level of interference from a single WCS terminal will reduce the Primosphere link margin from 6 dB to 3 dB causing a greater number of unreverable data errors when fading conditions are experienced and result in poor signal quality. If a **single** WCS mobile terminal was located only half this distance away from the SDARS receiver all link margin will be lost and the link will be broken making reception impossible. At this operating point the digital satellite transmission will incur a massive increase in unrecoverable bit errors, creating the effect to the user as lengthy "hits" or "jumps" in the received music channels and will cause SDARS receiver signal processing to "crash."

6. Impact of the revised out-of-band emissions levels on WCS transmit terminals.

Primosphere has paid special attention to ensure that the impact of our proposed reduction in out-of-band emissions can be readily and inexpensively implemented. Specifically there are several proven techniques that can be utilized by terminal manufacturers to meet the revised WCS out-of-band emissions levels with minimum impact on terminal costs. Given below is an example list of methods commonly used to reduce transmitter out-of-band emission levels, along with the level of improvement that could be expected;

Frequency Planning.	Frequency planning in the WCS bands can significantly reduce the impact of implementing the proposed out-of-band limits in the design of the WCS equipment. An example of a frequency plan is shown in Figure 2, where the mobile receive channels have been allocated directly adjacent to the SDARS receive bands. This allows the WCS transmit filter at least a full RF bandwidth to fall off, easing filter design and a higher attenuation in the SDARS band to be be realised.
Spectrum shaping	Spectrum shaping in the modulator can significantly limit the out-of-band spectrum level. For example, using square root raised cosine pulse shaping results in spectrum roll off of approximately 65 dB at the SDARS band edge, using the frequency plan given in Figure 2. Implementation of spectrum shaping signal processing would be at the signal processing level using DSP technology. Most transmitters already have spectrum shaping circuitry and thus there would be a negligible increase in production costs.
Filtering	Filtering in the WCS terminal can be used to provide attenuation to WCS out-of-band emissions into the SDARS

band. With the frequency plan suggested in Figure 2 filtering can easily provide attenuation of approximately 55 dB. It is proposed that the filtering be implemented prior to the final SSPA, where in band insertion loss is not a significant parameter. One suitable filter would be a IMCeramFil™, a low cost ceramic filter, available in production quantities from Integrated Microwave. In addition filtering at the output of the final RF power amplifier will provide some limited additional reduction in out of band emissions. This type of filtering is presently used in all PCS transmitters.

SSPA Back-off	The final SSPA stage in a WCS transmitter is a non- linear amplifier which will cause some spectrum re-growth. If the SSPA is operated at full saturation spectrum re-growth will be on the order of 25 dB. However operating the SSPA with a 4 dB input back-off will limit re-growth to 10 dB at the cost of only 10% drop in SSPA efficiency.
Cross Polarization	The use of opposite sense of polarization between the WCS and SDARS services will provide isolation of the order 15 dB. This is accomplished with no significant cost or operational impact on either the WCS or SDARS equipment.

With implementation of the above techniques values of 125 dB suppression of out-of-band emission can be achieved. Thus, the changes in the WCS out-of-band emission limits requested by Primosphere and the other SDARS applicants are feasible and can be implemented without major economic impact on WCS or constraints on its operations.

7. Practical measurement procedures to ensure that WCS transmit terminals meet the revised out-of-band emission requirements

Factory and/or laboratory measurements of out-of-band emissions from mobile and fixed WCS terminals meeting the 123+10Log(p) and 92+10Log(p) dB requirements can readily be accomplished by widely available standard off-the-shelf equipment. A fairly simple test configuration capable of performing both type acceptance and compliance testing is shown in Figure 3. The LNA is used to extend the measurement range of the spectrum analyzer by amplifying the input level to be within the dynamic range of the spectrum analyzer.

We have conservatively assumed that the test set with the LNA module and coupling connections has a noise figure of 2.0 dB which is well within the capability of a reasonably priced device (see attached data sheet for Mini-Circuits ZHL-1724HLN LNA module). With this LNA the test set noise temperature is 170° K, this corresponds to a thermal noise density of -206 dB/Hz or -161 dBW/30 KHz. Since we are trying to measure spectral levels of -129 dBW/KHz for a 1 W mobile transmitter, our test set thermal noise is well below the levels we are trying to measure. Thus, using an off-the-shelf LNA unit at the front end of the spectrum analyzer and standard microwave coupling hardware, out-of-band emission levels for mobile terminals of 123+10Log(p) dB, with a p=1 watt, will be 32 dB higher than the noise floor of the measurement setup. A similar measurement test configuration can be used for fixed terminals.

Suitable spectrum analyzers and LNA's are available from a wide number of sources, test engineers need only consult the test equipment catalog of Hewlett Packard, as one source, for suitable spectrum analyzers. As the enclosed data sheet illustrates, LNA modules operating in the 2 GHz band with the required noise figure are available, with Minicircuits being one reliable source of such components.

Compliance with the recommended out-of-band emission standards can be readily determined with off-the-shelf equipment using standard microwave measurement procedures. Thus, measurement procedures for WCS terminals meeting the revised out-of-band limits can therefore be readily adopted and FCC type acceptance tests be easily carried out.

8. Conclusions

SDARS is a satellite based mobile service operating with very low received signal power. SDARS will be operating in a band literally sandwiched between the two WCS bands. It is essential that out-of-band emissions from the adjacent WCS bands be carefully controlled to avoid interference and preserve a suitable SDARS service quality.

In its presentations to the Commission Primosphere has shown that:

1. The out-of-band limits proposed in the WCS NPRM are insufficient to protect SDARS from massive interference from WCS terminals;

2. The revised out-of-band emission limits for WCS terminals can be economically met through the use of proven technology; and,

3. The WCS terminals can be tested and out-of-band emissions measured for type approval and compliance testing using off-the shelf test equipment and standard test procedures.

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TABLE 1 WCS INTERFERENCE INTO SDARS ANALYSIS

PARAMETER	FIXED	MOBILE	
SDARS Receiver Noise Temperature	200.0	200.0	(deg K)
Noise Energy	-145.6	-145.6	(dBW/MHz)
Allowable Increase in Noise Energy	0.2	0.2	(dB)
Interference Noise Energy	-158.6	-158.6	(dBW/MHz)
Distance to SDARS Receive Antenna	30.0	1.0	(m)
Frequency	2320.0	2320.0	(MHZ)
Free Space Path Loss	69.3	39.8	(dB)
SDARS Antenna Gain	3.0	3.0	(dB)
Proposed FCC Isolation	70.0	43.0	(dB)
WCS Interference to SDARS *	-136.3	-79.8	(dBW/MHz)
Additional Isolation Required	22.3	78.9	(dB)
Proposed Isolation Specification	92	122	(dB)

* Referenced to 0 dBW

07-Jan-97

Figure 1. Noise Power into SDARS Receiver vs Range

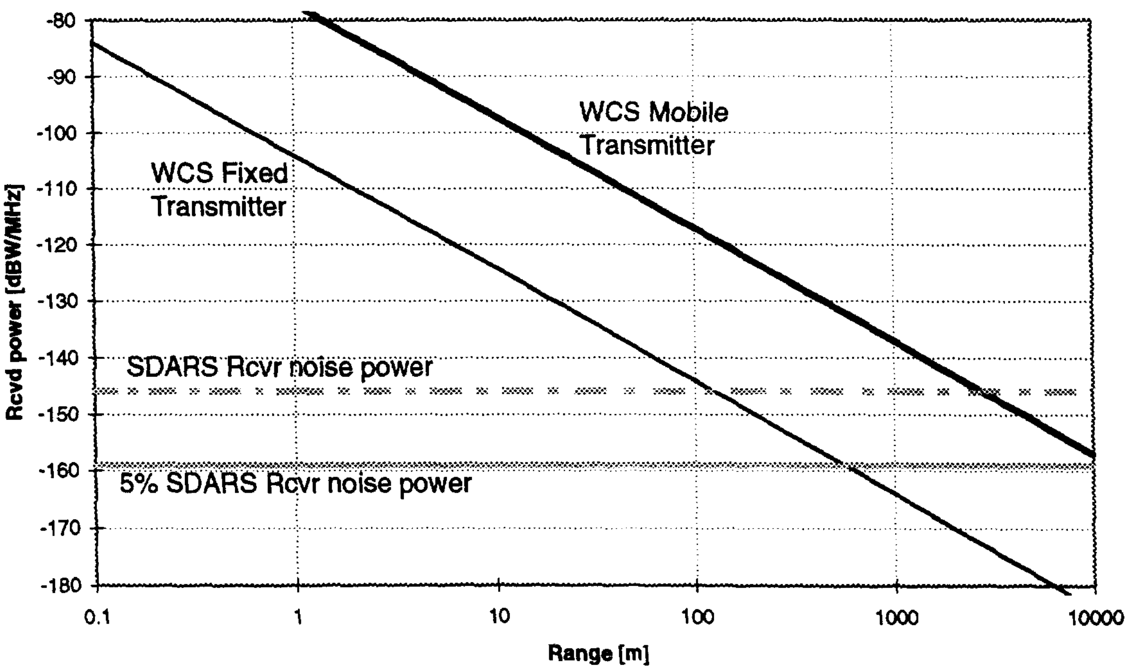


FIGURE 2 POSSIBLE SPECTRUM ALLOCATION FOR WCS AND SDARS

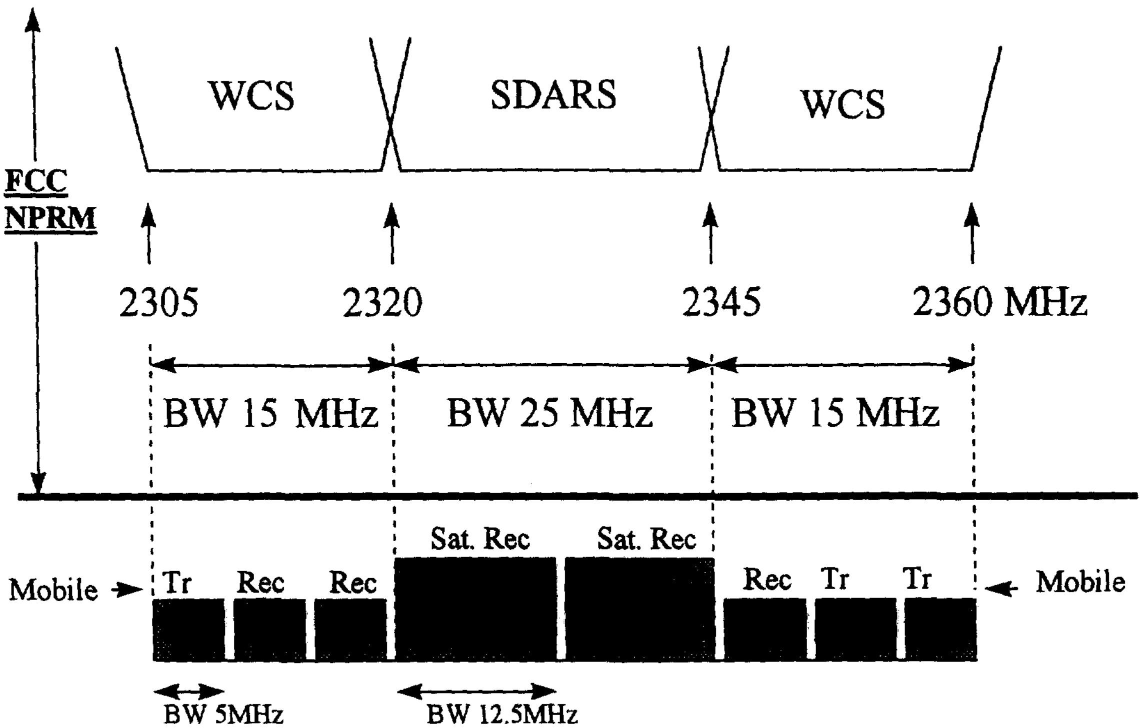
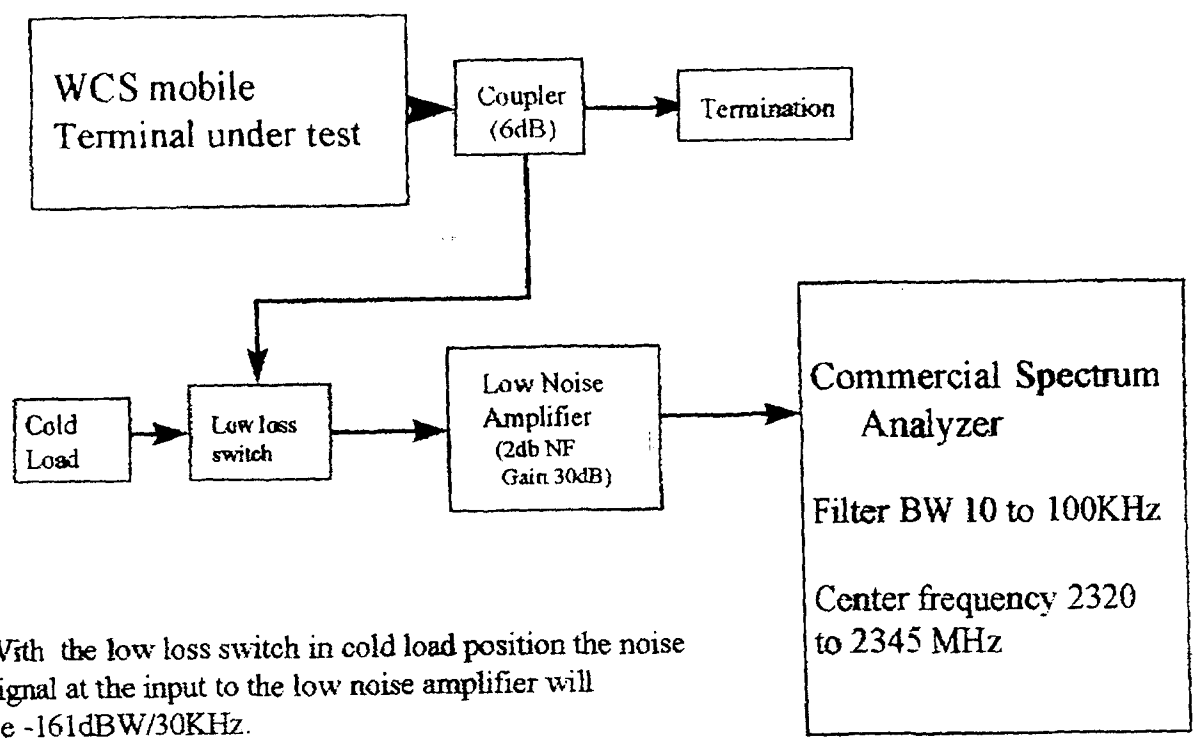


FIGURE 3 MEASUREMENTS TECHNIQUE FOR OUT-OF-BAND EMISSION



With the low loss switch in cold load position the noise signal at the input to the low noise amplifier will be -161dBW/30KHz.

With a WCS terminal power of 1 watt and bandwidth 30KHZ, the out of band emission will be -129dBW/30KHz or 32 dB above the measurement noise

Typical LNA

NEC

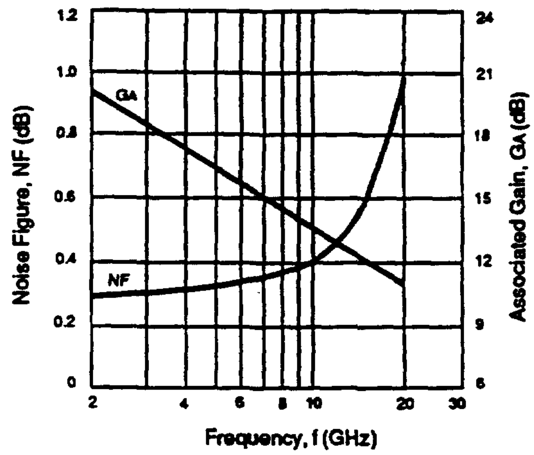
ULTRA LOW NOISE PSEUDOMORPHIC HJ FET

NE32584C

FEATURES

- **VERY LOW NOISE FIGURE:** 0.45 dB Typical at 12 GHz
- **HIGH ASSOCIATED GAIN:** 12.5 dB Typical at 12 GHz
- **$L_G \leq 0.20$ µm, $W_G = 200$ µm**
- **LOW COST METAL CERAMIC PACKAGE**
- **TAPE & REEL PACKAGING OPTION AVAILABLE**

NOISE FIGURE & ASSOCIATED GAIN vs. FREQUENCY
$V_{DS} = 2$ V, $I_{DS} = 10$ mA



DESCRIPTION

The NE32584C is a pseudomorphic Hetero-Junction FET that uses the junction between Si-doped AlGaAs and undoped InGaAs to create very high mobility electrons. The device features mushroom shaped TiAl gates for decreased gate resistance and improved power handling capabilities. The mushroom gate also results in lower noise figure and high associated gain. This device is housed in an epoxy-sealed, metal/ceramic package and is intended for high volume consumer and industrial applications.

NEC's stringent quality assurance and test procedures assure the highest reliability and performance.

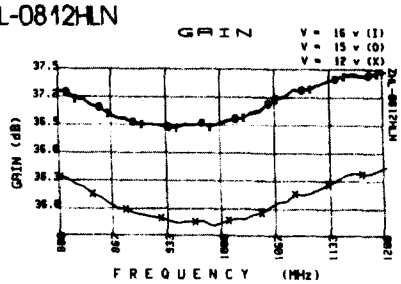
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$)

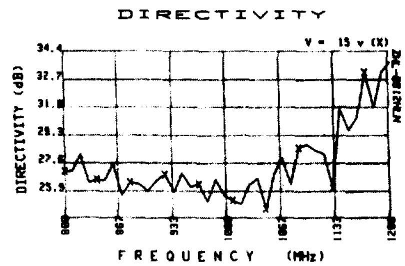
	PART NUMBER PACKAGE OUTLINE		NE32584C 84C		
SYMBOLS	PARAMETERS AND CONDITIONS	UNITS	MIN	TYP	MAX
NF[1]	Optimum Noise Figure, $V_{DS} = 2$ V, $I_{DS} = 10$ mA, f = 12 GHz	dB		0.45	0.55
GA[1]	Associated Gain, $V_{DS} = 2$ V, $I_{DS} = 10$ mA, f = 12 GHz	dB	11.0	12.5	
I_{DSS}	Saturated Drain Current, $V_{DS} = 2$ V, $V_{GS} = 0$ V	mA	20	60	90
V_P	Pinch-off Voltage, $V_{DS} = 2$ V, $I_{DS} = 100$ µA	V	-2.0	-0.7	-0.2
g_m	Transconductance, $V_{DS} = 2$ V, $I_D = 10$ mA	mS	45	60	
I_{GSO}	Gate to Source Leakage Current, $V_{GS} = -3$ V	µA		0.5	10.0
$R_{TH(CH-A)}$	Thermal Resistance (Channel to Ambient)	°C/W		750	
$R_{TH(CH-C)}$	Thermal Resistance (Channel to Case)	°C/W			350

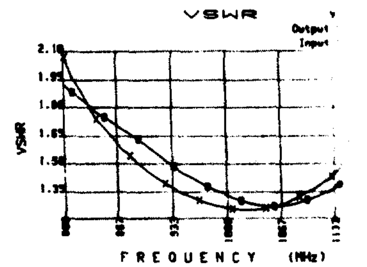
Note:
1. Typical values of noise figures and associated gain are those obtained when 50% of the devices from a large number of lots were individually measured in a circuit with the input individually tuned to obtain the minimum value. Maximum values are criteria established on the production line as a "go-no-go" screening tuned for the "generic" type but not each specimen.

Amplifiers

ZHL-0812HLN



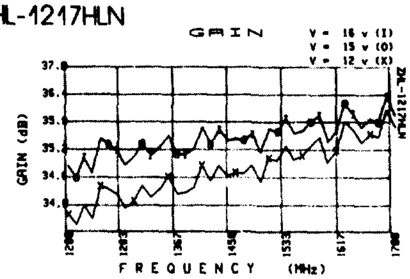


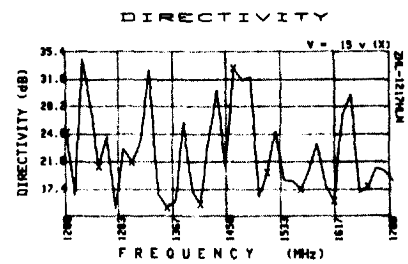


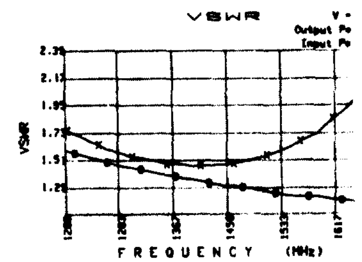
FREQUENCY (MHz)	GAIN (dB) 12.0V	15.0V	16.0V	DIRECTIVITY (dB) 12.0V	15.0V	16.0V	SWR IN	OUT	N.F. (db)	P_{out} (@1dE
800.0	36.34	37.28	37.26	28.0	26.9	28.0	2.06	1.91	1.13	
829.0	36.24	37.20	37.19	26.8	26.3	26.9	1.80	1.81	1.11	
869.2	36.02	36.99	36.98	28.2	25.5	24.3	1.57	1.68	1.07	
911.5	35.92	36.92	36.93	27.2	26.4	25.9	1.42	1.56	1.06	
953.8	35.87	36.93	36.91	26.7	26.0	24.8	1.32	1.43	1.08	
994.9	35.85	36.94	36.93	26.0	25.5	25.1	1.26	1.33	1.09	
1046.2	35.96	37.08	37.06	28.0	24.7	27.7	1.26	1.27	1.11	
1097.4	36.16	37.29	37.28	27.7	28.6	27.4	1.34	1.30	1.16	
1148.7	36.37	37.46	37.44	30.1	29.5	29.6	1.50	1.41	1.23	
1200.0	36.46	37.49	37.49	32.1	33.6	34.1	1.74	1.55	1.34	

σ equals standard deviation, see Amplifier terms

ZHL-1217HLN



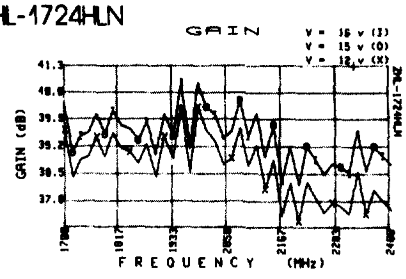


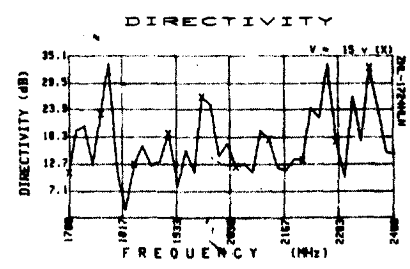


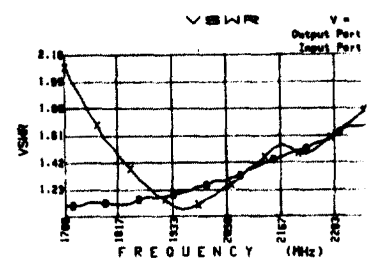
FREQUENCY (MHz)	GAIN (dB) 12.0V	15.0V	16.0V	DIRECTIVITY (dB) 12.0V	15.0V	16.0V	SWR IN	OUT	N.F. (db)	P_{out} (@1dBC
1200.0	33.75	34.80	34.82	28.7	24.8	26.1	1.75	1.59	1.30	26
1236.6	33.66	34.66	34.66	26.9	28.1	34.4	1.66	1.53	1.26	26
1287.0	33.89	34.84	34.83	20.9	22.7	16.8	1.56	1.46	1.24	26
1339.6	34.30	35.21	35.21	26.0	16.9	26.3	1.50	1.40	1.20	26
1392.3	34.34	35.18	35.19	22.7	17.2	15.1	1.46	1.36	1.16	26
1443.6	34.60	35.37	35.36	20.2	20.2	29.2	1.48	1.30	1.14	27
1507.7	35.00	35.64	35.63	17.9	19.6	24.0	1.55	1.26	1.13	27
1571.8	35.26	35.78	35.79	23.1	19.8	23.0	1.69	1.21	1.15	28
1635.9	35.60	35.95	35.95	19.3	29.8	14.3	1.95	1.18	1.22	28
1700.0	35.67	35.94	35.93	12.6	18.6	13.4	2.32	1.14	1.35	28

σ equals standard deviation, see Amplifier terms

ZHL-1724HLN







FREQUENCY (MHz)	GAIN (dB) 12.0V	15.0V	16.0V	DIRECTIVITY (dB) 12.0V	15.0V	16.0V	SWR IN	OUT	N.F. (db)	P_{out} (dB @1dBCO
1700.0	39.56	40.17	40.15	11.2	10.7	17.3	2.09	1.11	1.33	27.6
1751.2	38.88	39.50	39.50	15.2	12.3	12.2	1.77	1.14	1.21	27.5
1821.9	39.10	39.69	39.66	15.8	3.1	14.6	1.44	1.12	1.10	27.3
1895.5	38.37	38.94	38.93	23.5	13.2	9.0	1.19	1.17	1.08	27.3
1969.2	38.48	39.09	39.09	15.2	10.9	14.8	1.10	1.22	1.12	27.0
2041.0	38.68	39.37	39.35	24.6	16.9	21.5	1.24	1.29	1.16	26.9
2130.8	38.05	38.89	38.87	13.3	17.8	17.3	1.46	1.42	1.20	26.7
2220.5	38.23	39.17	39.16	10.6	24.2	10.6	1.48	1.52	1.21	26.5
2310.3	37.42	38.47	38.48	17.3	26.6	13.9	1.69	1.68	1.20	26.4
2400.0	37.51	38.68	38.69	13.8	14.9	14.8	1.98	1.76	1.19	26.1

σ equals standard deviation, see Amplifier terms